# Texas State Soil and Water Conservation Board
# State Nonpoint Source Grant Program
# FY 2013 Project Workplan 13-56

| SUMMARY PAGE | | | |
|---|---|---|---|
| Title of Project | Bacteria Growth, Persistence, and Source Assessment in Rural Texas Landscapes and Streams | | |
| Project Goals | • Assess the influences of sediment and water chemistry on instream *E. coli* growth and persistence<br>• Evaluate the sources of 'background' *E. coli* on varying land use/land cover (LU/LC) types containing little or no anthropogenically derived *E. coli* loading<br>• Support the development of future TMDLs and WPPs by providing critical information needed for improving the accuracy of computer based models to predict bacteria deposition rate estimates; die-off, growth, and persistence of *E. coli*; and appropriate background *E. coli* concentrations across multiple LU/LC types | | |
| Project Tasks | (1) Project Administration; (2) Quality Assurance; (3) Simulated Instream Growth and Persistence Assessment; (4) *E. coli* Source Assessment of Varying LU/LC Types; (5) Education and Outreach | | |
| Measures of Success | • Instream water quality parameters identified and their impacts on *E. coli* growth and persistence in simulated stream environments quantified<br>• Dominant sources of 'naturally occurring' *E. coli* identified on varying LU/LC types<br>• Project results published in peer-reviewed literature and disseminated to appropriate parties for incorporating improved *E. coli* decay, growth, and die-off rates into computer-based modeling utilized in TMDL and WPP development | | |
| Project Type | Implementation (x); Education ( ); Planning ( ); Assessment (x); Groundwater ( ) | | |
| Status of Waterbody on *2010 Texas Integrated Report* | Segment ID<br>Carters Creek 1209C<br>Big Creek 1242P | Parameter<br>Bacteria<br>Bacteria | Category<br>5a<br>5b |
| Project Location (Statewide or Watershed and County) | Carters Creek watershed in Brazos County<br>Big Creek watershed in Falls County | | |
| Key Project Activities | Hire Staff (x); Surface Water Quality Monitoring (x); Technical Assistance ( );<br>Education (x); Implementation (x); BMP Effectiveness Monitoring ( );<br>Demonstration (x); Planning ( ); Modeling ( ); Bacterial Source Tracking (x); Other ( ) | | |
| *Texas NPS Management Program* Components | • Component 1: LTG Obj: 1, 2, 3, 7; STG 1B, 1C; 2D; 3A; 3D; 3G<br>• Components 2, 3, 4, 5 | | |
| Project Costs | $ 346,612, | | |
| Project Management | • Texas Water Resources Institute | | |
| Project Period | June 1, 2013 – May 31, 2015 | | |

## Part I – Applicant Information

| Applicant | | | | | | | |
|---|---|---|---|---|---|---|---|
| Project Co-Lead | Kevin Wagner | | | | | | |
| Title | Associate Director | | | | | | |
| Organization | Texas Water Resources Institute, Texas A&M AgriLife Research | | | | | | |
| E-mail Address | klwagner@ag.tamu.edu | | | | | | |
| Street Address | 1500 Research Pkwy, Ste A240<br>2260 TAMU | | | | | | |
| City | College Station | County | Brazos | State | TX | Zip Code | 77843-2260 |
| Telephone Number | 979-845-1851 | | | Fax Number | 979-845-8554 | | |

| Applicant | | | | | | | |
|---|---|---|---|---|---|---|---|
| Project Co-Lead | Lucas Gregory | | | | | | |
| Title | Project Specialist & QA Officer | | | | | | |
| Organization | Texas Water Resources Institute, Texas A&M AgriLife Research | | | | | | |
| E-mail Address | lfgregory@ag.tamu.edu | | | | | | |
| Street Address | 1500 Research Pkwy, Ste A240<br>2260 TAMU | | | | | | |
| City | College Station | County | Brazos | State | TX | Zip Code | 77843-2260 |
| Telephone Number | 979-845-1851 | | | Fax Number | 979-845-8554 | | |

| Co-Applicant | | | | | | | |
|---|---|---|---|---|---|---|---|
| Project Co-Lead | R. Karthikeyan | | | | | | |
| Title | Associate Professor | | | | | | |
| Organization | Department of Biological and Agricultural Engineering, Texas A&M AgriLife Research | | | | | | |
| E-mail Address | karthi@tamu.edu | | | | | | |
| Street Address | 2117 TAMU | | | | | | |
| City | College Station | County | Brazos | State | TX | Zip Code | 77843-2117 |
| Telephone Number | 979-845-7951 | | | Fax Number | 979-845-3932 | | |

| Co-Applicant | | | | | | | |
|---|---|---|---|---|---|---|---|
| Project Co-Lead | Terry Gentry | | | | | | |
| Title | Associate Professor | | | | | | |
| Organization | Department of Soil and Crop Sciences, Texas A&M University | | | | | | |
| E-mail Address | tgentry@ag.tamu.edu | | | | | | |
| Street Address | 2474 TAMU | | | | | | |
| City | College Station | County | Brazos | State | TX | Zip Code | 77843-2474 |
| Telephone Number | 979-845-5323 | | | Fax Number | 979-845-0456 | | |

| Co-Applicant | | | | | | | |
|---|---|---|---|---|---|---|---|
| Project Co-Lead | Daren Harmel | | | | | | |
| Title | Agricultural Engineer; Adjunct Professor | | | | | | |
| Organization | USDA Agricultural Research Service; Department of Biological and Agricultural Engineering | | | | | | |
| E-mail Address | daren.harmel@ars.usda.gov | | | | | | |
| Street Address | 808 East Blackland Rd. | | | | | | |
| City | Temple | County | Bell | State | TX | Zip Code | 75602 |
| Telephone Number | 254-770-6521 | | | Fax Number | | | |

| **Co-Applicant** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Project Co-Lead | Roel Lopez | | | | | | |
| Title | Interim Director and Professor | | | | | | |
| Organization | Interim Director, Texas A&M Institute of Renewable Natural Resources and the Texas Water Resources Institute; Professor, Department of Wildlife and Fisheries Science, Texas A&M University | | | | | | |
| E-mail Address | roel@tamu.edu | | | | | | |
| Street Address | 2260 TAMU | | | | | | |
| City | College Station | County | Brazos | State | TX | Zip Code | 77843-2260 |
| Telephone Number | 979-845-1851 | | | Fax Number | 979-845-0662 | | |

| **Co-Applicant** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Project Co-Lead | Saqib Mukhtar | | | | | | |
| Title | Professor, Interim Associate Department Head & Extension Program Leader | | | | | | |
| Organization | Department of Biological and Agricultural Engineering, Texas A&M AgriLife Extension Service | | | | | | |
| E-mail Address | mukhtar@tamu.edu | | | | | | |
| Street Address | 2117 TAMU | | | | | | |
| City | College Station | County | Brazos | State | TX | Zip Code | 77843-2117 |
| Telephone Number | 979-458-1019 | | | Fax Number | 979-845-3932 | | |

| **Co-Applicant** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Project Co-Lead | Jacqueline Aitkenhead-Peterson | | | | | | |
| Title | Assistant Professor of Urban Nutrient and Water Management | | | | | | |
| Organization | Department of Soil and Crop Sciences, Texas A&M University | | | | | | |
| E-mail Address | jpeterson@ag.tamu.edu | | | | | | |
| Street Address | 2474 TAMU | | | | | | |
| City | College Station | County | Brazos | State | TX | Zip Code | 77843-2474 |
| Telephone Number | 979-845-3682 | | | Fax Number | 979-845-0456 | | |

| **Project Partners** | |
|---|---|
| Names | Roles & Responsibilities |
| Texas State Soil and Water Conservation Board (TSSWCB) | Provide state oversight and management of all project activities and ensure coordination of activities with related projects and TCEQ. |
| Texas A&M AgriLife Research, Texas Water Resources Institute (TWRI) | Project coordination and administration; QAPP development; project reporting; website development; education and outreach; simulated instream *E. coli* response to water quality modifications; LU/LC source assessments; education and outreach. |
| Texas A&M AgriLife Research – Department of Biological and Agricultural Engineering (BAEN) | Assess simulated instream *E. coli* response to water quality modifications; LU/LC source assessments; education and outreach. |
| Texas A&M AgriLife Research – Department of Soil and Crop Sciences (SCSC) Soil and Aquatic Microbiology Lab (SAML) | Bacteria Source Tracking (BST) sample analysis; LU/LC bacteria source assessments. |
| Texas A&M AgriLife Research – Department of Soil and Crop Sciences (SCSC) Nutrient and Water Analysis Lab (NAWA) | Carbon and phosphorus analysis of water and sediment samples. |
| Texas A&M AgriLife Research, Wildlife and Fisheries Department, Texas A&M University, Institute of Renewable Natural Resources (IRNR) | Wildlife population surveys and density estimates; LU/LC source assessments. |
| United States Department of Agriculture-Agricultural Research Service, Grasslands Soil and Water Research Laboratory (USDA-ARS) | Site instrumentation and sample collection; LU/LC source assessment assistance. |

## Part II – Project Information

| **Project Type** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Surface Water | x | Groundwater | | | | | |
| Does the project implement recommendations made in (a) a completed WPP, (b) an adopted TMDL, (c) an approved I-Plan, or (d) a Comprehensive Conservation and Management Plan developed under CWA §320? | | | | Yes | | No | x |
| If yes, identify the document. | | | | | | | |
| If yes, identify the agency/group that developed and/or approved the document. | | | | Year Developed | | | |

| **Watershed Information** | | | | |
|---|---|---|---|---|
| Watershed Name(s) | Hydrologic Unit Code (12 Digit) | Segment ID | 305(b) Category | Size (Acres) |
| Carters Creek | 120701030702, 120701030704 | 1209C | 5a | 36,424 |
| Big Creek | 120701010201 thru 120701010208 & 120701010302 | 1242P | 5b | 240,521 |

**Water Quality Impairment**

Describe all known causes (pollutants of concern) of water quality impairments or concerns from any of the following sources: *2010 Texas Integrated Report*, Clean Rivers Program Basin Summary/Highlights Reports or other documented sources.

**Source of Information:** *2010 Texas Integrated Report*

***Segment 1209C; Carters Creek; Unclassified water body***
Perennial stream from the confluence with the Navasota River southeast of College Station in Brazos County upstream to the confluence of an unnamed tributary 0.5 km upstream of FM 158 in Brazos County

**Flow Type:** *Perennial* **ALU Designation:** *Intermediate* **Current Bacteria Geomean:** 753.1 cfu/100mL
**Station IDs: 11784, 11785**

| Area | Impairment/Concern | Category | Year First Listed |
|---|---|---|---|
| 1209C_01 Entire water body | Bacteria | 5a | 1999 |
| | Nitrate | CS | |
| | Orthophosphorus | CS | |
| | Total Phosphorus | CS | |

**TCEQ Sources:** ***Bacteria***: NPS- Animal Feeding Operations (NPS); PS- Municipal Point Source Discharges; NPS- Rangeland Grazing; ***Nitrate/Orthophosphorus/Total Phosphorus***: NPS- Animal Feeding Operations (NPS); PS- Municipal Point Source Discharges; NPS- Rangeland Grazing; NPS- Unspecified Urban Stormwater

***Segment 1242P; Big Creek; Unclassified water body***
From the confluence with Little Brazos River in Falls County upstream to the confluence with unnamed creeks near Mart in the northeast corner of Falls County

**Flow Type:** *Intermittent* **ALU Designation:** *Minimal* **Current Bacteria Geomean:** 314.4 cfu/100mL
**Station IDs: 16400**

| Area | Impairment/Concern | Category | Year First Listed |
|---|---|---|---|
| 1242P_01 Downstream portion of water body | bacteria | 5b | 2002 |

**TCEQ Sources:** ***Bacteria*****:** NPS- Non-Point Source; NPS- Permitted Runoff from Confined Animal Feeding Operations (CAFOs)

**Project Narrative**

Problem/Need Statement

Bacteria impairments have been and continue to constitute the bulk of individual waterbody impairments in the state. As illustrated in the *2010 Texas Water Quality Inventory and 303(d) List*, 621 impairments are documented in Texas and 319 of those are attributed to bacteria. This represents roughly 51% of all impairments in the state. The *Draft 2012 Texas Integrated Report* will illustrate similar levels of bacteria impairments once approved further emphasizing the need to better understand the sources and fate of bacteria in watersheds so that these impairments can be effectively addressed and managed.

Despite having been studied for several decades, many shortcomings exist in knowledge about fate and transport of *Escherichia coli (E. coli)* in the environment. In freshwater streams, *E. coli* are used as an indicator of fecal material from warm-blooded animals present in the water column. Initial assumptions were that these indicator organisms only existed in the gastrointestinal tracts of warm-blooded animals or their freshly excreted fecal material. This dogma regarding *E. coli's* reliance on the intestinal tract of warm-blooded animals led to its widespread use as an indicator of fecal contamination. Recent work has shown that *E. coli* can persist and grow outside of their host in both soil and water (Bolster et al. 2005; Ishii et al. 2006; Habteselassie et al. 2008; Vital et al. 2008; Garzio-Hadzick et al. 2010; Harmel et al. 2010; Vital et al. 2010) thus jeopardizing their effectiveness as accurate indicators of fecal contamination.

State-wide, watershed managers are currently utilizing tools to predict the sources, population dynamics (i.e. occurrence, growth, persistence), and transport of bacteria and are subsequently planning and implementing management strategies to address bacteria loadings into a waterbody based on these available tools. Given the fact that the sources and fate of *E. coli* in the environment are poorly understood, these tools cannot be expected to accurately illustrate *E. coli* behavior much less be able to accurately illustrate how planned management practices may alter current *E. coli* loadings.

In 2009, the final version of the "Bacterial TMDL Task Force Report" was published culminating discussions among experts in the field of bacteria related water resources management. This report focused on describing appropriate and cost-effective ways to implement bacteria TMDLs in Texas. Additionally, the report also identified needs for further evaluations to reduce uncertainty about bacteria behavior under varying water conditions in Texas. Largely in response to this report, the "Fate and Transport of *E. coli* in Rural Texas Landscapes and Streams" project (TSSWCB Project 07-06) was developed to begin addressing some of the identified information needs. Results of this work illustrated that the presence, fate and transport of bacteria is highly variable. *E. coli* concentrations varied widely within and between species as did the kinetic growth and decay constants for *E. coli* from each species. Evaluations of *E. coli* from other animal species were identified as a critical need for future watershed bacteria studies. Additionally, environmental factor (temperature and moisture) variations were also found to significantly influence *E. coli* survival and growth. Future work to evaluate fluctuations in nutrient conditions under simulated 'natural' conditions was recommended as a way to evaluate the response of *E. coli* in the water and sediment profiles to changes in stream water quality.

This need for additional investigation is echoed in the "Bacteria TMDL Task Force Report." The report expressly states that "studies to identify dominant environmental factors that affect bacterial transport in streams (e.g., physical and chemical composition of stream waters [pH, total suspended solids, total dissolved solids, nutrients, etc.], temperature, etc.)," are needed to better characterize the kinetic growth and decay rates of bacteria in stream environments. Additionally, the interactions of water and sediment in the stream environment are not clearly defined and need to be better understood. Contributions of wastewater and associated nutrients to stream systems further complicate instream regrowth issues and are pointed to in the "Bacteria TMDL Task Force Report" as a needed area of exploration.

**Project Narrative**

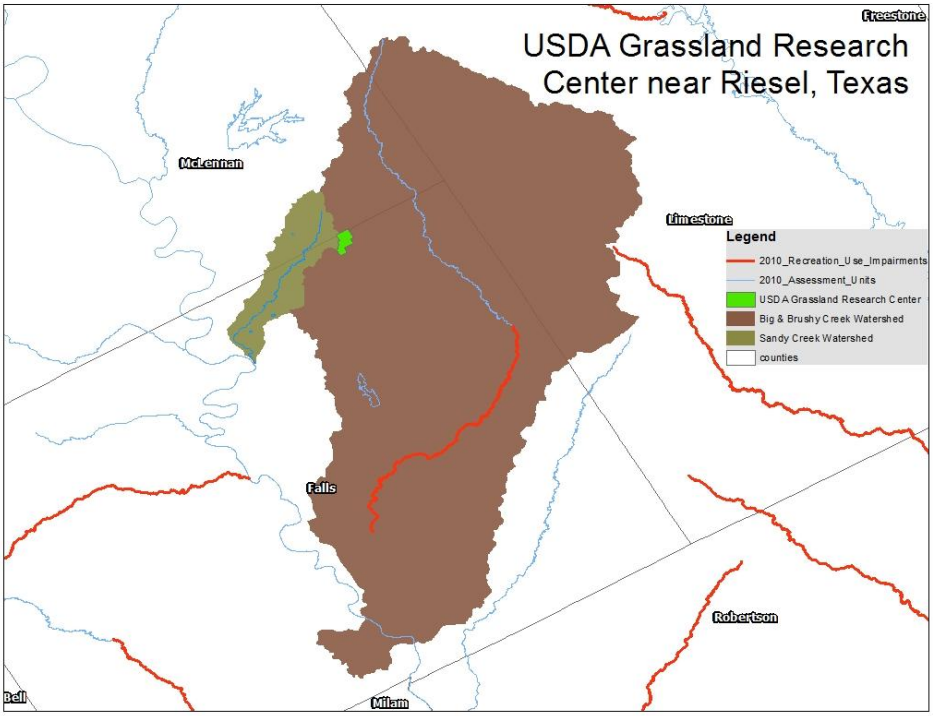
General Project Description (Include Project Location Map)

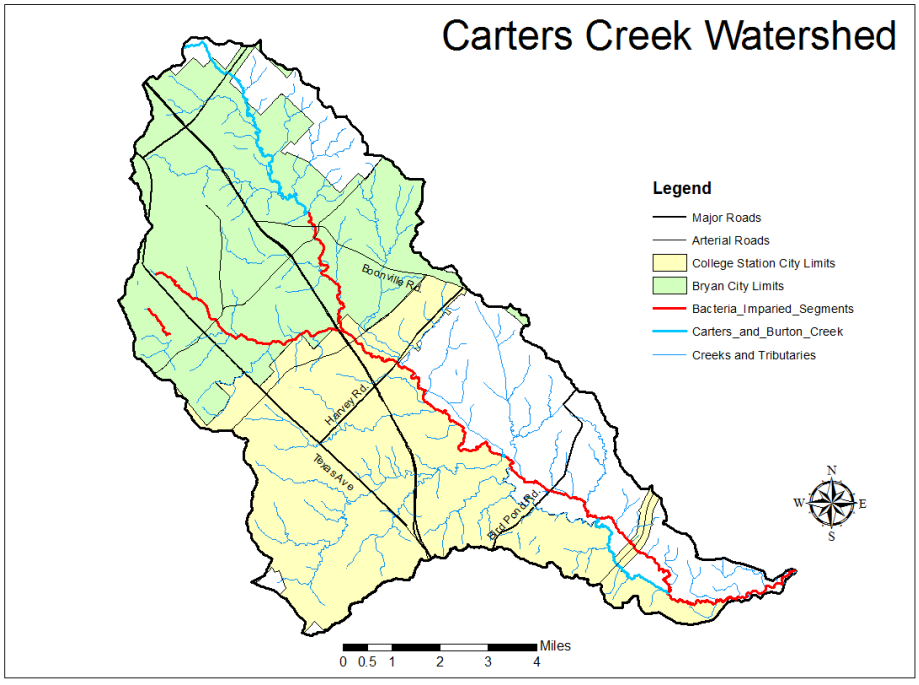
Building upon results from TSSWCB Project 07-06 and further focusing on addressing informational needs identified in the "Bacteria TMDL Task Force Report," this project will focus on two primary tasks: 1) evaluating the predominant water quality parameters affecting instream bacterial fate and 2) evaluating and quantifying contributing *E. coli* loading to designated LU/LC types. These specific tasks were selected as those that will provide the most valuable information to watershed managers and practitioners who are faced with accurately predicting and planning to manage *E. coli* loading in Texas Watersheds. This will be supported by education and outreach efforts that deliver project results to personnel at local, regional, state and national levels.

Instream water quality parameters affecting *E. coli* growth and persistence will be quantified utilizing simulated stream environments. Flow chambers will be constructed in a laboratory setting to enable selected environmental parameters to be controlled and manipulated among multiple replications of simulated instream conditions. Flow chambers will consist of water tight channels fitted with water pumps that will re-circulate water and allow flow to mimic 'natural' low flow conditions. The flow rate of the water pumps can be adjusted to allow for adjustments to the simulated flow conditions. Flow chambers will be filled with stream water collected from Carters Creek under various flow conditions. (see following map). Once in the flow chambers, water will be sampled at prescribed time intervals and will be evaluated to concurrently determine changes in *E. coli*, Dissolved Oxygen (DO), Dissolved Organic Carbon (DOC), pH, nutrient parameters (Ammonium, Nitrate, and Phosphorus) and turbidity. Individual parameter spikes will be periodically conducted to illustrate the direct impact of each parameter on *E. coli* growth and persistence.

Bacteria source identification will be conducted on multiple LU/LC types monitored at the USDA-ARS Grassland Research Facility in Riesel (see following map). USDA-ARS will collect 20 surface runoff samples and 25 soil samples from each of 3 established catchments in Riesel. USDA-ARS will remit samples to SAML for *E. coli* enumeration and BST analysis. SAML will utilize the library-dependent ERIC-RP BST technique and compare results to both a local and state-wide BST library to evaluate the sources contributing bacteria to specific LU/LCs. Camera trap arrays will be established on each LU/LC type to monitor and estimate species presence and develop species indices. Known sources of fecal material will be collected, processed and incorporated into the Texas *E. coli* BST Library and utilized in the library-dependent BST analysis to further support bacteria loading identification.

Delivery of project results and findings is a critical last step that will be completed through this project. Information on these topics is in high demand and ample opportunities exist to deliver findings to interested parties through focused workshops, meetings and conferences. One such avenue that results will potentially be presented at is the Texas Watershed Coordinator Roundtable. The July 27, 2011 meeting of this group focused solely on bacteria related content and this was by far the biggest audience at these roundtable events to date. The engagement of the audience clearly illustrated the desired/need for further information on bacteria related topics, especially those that will be addressed through this project. Development of peer-reviewed publications (or working drafts) is another way that education and outreach will be achieved through this project. Additionally, this provides extra credibility to the work done thus solidifying the significance of the work conducted through this project and enabling it to be more rapidly and widely utilized.


USDA Grassland Research Center near Riesel, Texas
Freestone
McLennan
Limestone
Falls
Robertson
Bell
Milam
Legend
2010_Recreation_Use_Impairments
2010_Assessment_Units
USDA Grassland Research Center
Big & Brushy Creek Watershed
Sandy Creek Watershed
counties


Carters Creek Watershed
Legend
Major Roads
Arterial Roads
College Station City Limits
Bryan City Limits
Bacteria_Imparied_Segments
Carters_and_Burton_Creek
Creeks and Tributaries
Boonville Rd
Harvey Rd
Texas Ave
Bird Pond Rd
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W
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0 0.5 1 2 3 4

| **Tasks, Objectives and Schedules** | | | | |
|---|---|---|---|---|
| Task 1 | Project Administration | | | |
| Costs | $37,520 | | | |
| Objective | To effectively administer, coordinate and monitor all work performed under this project including technical and financial supervision and preparation of status reports. | | | |
| Subtask 1.1 | TWRI will prepare electronic quarterly progress reports (QPRs) for submission to the TSSWCB. QPRs shall document all activities performed within a quarter and shall be submitted by the 15th of March, June, September and December. QPRs will be distributed to all Project Partners. | | | |
| | Start Date | Month 1 | Completion Date | Month 24 |
| Subtask 1.2 | TWRI will perform accounting functions for project funds and will submit appropriate Reimbursement Forms to TSSWCB at least quarterly. | | | |
| | Start Date | Month 1 | Completion Date | Month 24 |
| Subtask 1.3 | TWRI will host coordination meetings or conference calls as needed with Project Partners to discuss project activities, project schedule, communication needs, deliverables, and other requirements. TWRI will develop lists of action items needed following each project coordination meeting and distribute to project personnel. | | | |
| | Start Date | Month 1 | Completion Date | Month 24 |
| Subtask 1.4 | TWRI, with assistance from other project partners will develop a final project report. | | | |
| | Start Date | Month 20 | Completion Date | Month 24 |
| Deliverables | • Quarterly progress reports in electronic format<br>• Reimbursement Forms and necessary documentation in hard copy format<br>• Final Report in electronic and hard copy formats | | | |

| **Tasks, Objectives and Schedules** | | | | |
|---|---|---|---|---|
| Task 2 | Quality Assurance | | | |
| Costs | $4,500 | | | |
| Objective | To develop data quality objectives (DQOs) and quality assurance/control (QA/QC) activities to ensure data of known and acceptable quality are generated through this project. | | | |
| Subtask 2.1 | TWRI, with assistance from other project partners, will develop a QAPP for activities in Tasks 3 and 4 consistent with the most recent versions of *EPA Requirements for Quality Assurance Project Plans (QA/R-5)* and the *TSSWCB Environmental Data Quality Management Plan*. All monitoring procedures and methods prescribed in the QAPP shall be consistent with the guidelines detailed in the *TCEQ Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue (RG-415)*. [Consistency with Title 30, Chapter 25 of the Texas Administrative Code, *Environmental Testing Laboratory Accreditation and Certification*, which describes Texas' approach to implementing the National Environmental Laboratory Accreditation Conference (NELAC) standards, shall be required where applicable.] | | | |
| | Start Date | Month 1 | Completion Date | Month 4 |
| Subtask 2.2 | TWRI will implement the approved QAPP. TWRI will submit revisions and necessary amendments to the QAPP as needed. | | | |
| | Start Date | Month 4 | Completion Date | Month 24 |
| Deliverables | • QAPP approved by TSSWCB in both electronic and hard copy formats<br>• Approved revisions and amendments to QAPP, as needed<br>• Data of known and acceptable quality as reported through Task 3 and 4 | | | |

| **Tasks, Objectives and Schedules** | | | | |
|---|---|---|---|---|
| Task 3 | Instream *E. coli* Growth and Persistence Assessment | | | |
| Costs | $84,050 | | | |
| Objective | To assess the impacts of varying instream water quality on *E. coli* growth and persistence in stream sediments and the water column. | | | |
| Subtask 3.1 | TWRI and BAEN will establish laboratory-scale flow chambers to simulate stream environments in a controlled setting. | | | |
| | Start Date | Month 1 | Completion Date | Month 4 |
| Subtask 3.2 | TWRI and BAEN will populate flow chambers with known volumes of various types of water from the Carters Creek watershed. | | | |
| | Start Date | Month 4 | Completion Date | Month 20 |
| Subtask 3.3 | TWRI and BAEN will conduct replicated monitoring and analysis over time to simulate instream conditions and assess temporal variations in *E. coli* growth and persistence in response to water quality changes (DO, DOC, pH, ammonium, nitrate, phosphorus, and turbidity). With the exception of DOC, these parameters will be monitored continuously using automated instrumentation. Water will be monitored by sampling the approximate midpoint of the flowing water column. Ten water samples will be collected from each flow chamber per trial at defined time intervals. Simulations in triplicate; one control and two treatments. Treatment will consist of stream water spiked with prescribed nutrient amendments to evaluate *E. coli* response. | | | |
| | Start Date | Month 4 | Completion Date | Month 20 |
| Subtask 3.4 | TWRI and BAEN will evaluate bacterial population dynamics in response to varying levels of nutrients and will simultaneously monitor DO, pH, and turbidity. Using this information, relevant rates of growth and die-off will be calculated and a descriptive summary of findings and results for use in the project final report and other published materials will be produced. | | | |
| | Start Date | Month 14 | Completion Date | Month 20 |
| Deliverables | • Evaluation of bacterial growth and die-off in response to varying water quality conditions | | | |

| **Tasks, Objectives and Schedules** | | | | |
|---|---|---|---|---|
| Task 4 | *E. coli* Source Assessment on Varying LU/LC Types | | | |
| Costs | $186,553 | | | |
| Objective | To identify potential sources of *E. coli* contributed to select LU/LC types and verify their source using BST | | | |
| Subtask 4.1 | IRNR will establish camera trap arrays on each LU/LC type and operate them for two week intervals in summer and winter to document species presence and establish species indices. | | | |
| | Start Date | Month 4 | Completion Date | Month 16 |
| Subtask 4.2 | Using survey data collected in Subtask 4.1, TWRI/BAEN will develop estimated fecal loading rates from known source fecal samples collected from identified species (Subtask 4.3) contributing *E. coli* in each LU/LC type. Estimated fecal production rates for each species will be utilized in this estimation. | | | |
| | Start Date | Month 16 | Completion Date | Month 20 |
| Subtask 4.3 | IRNR/USDA-ARS as appropriate will collect identified sources of fecal material at each selected location and transfer samples to SAML where *E. coli* colonies will be isolated from these known sources. Identified *E. coli* will be DNA fingerprinted and included in the *Texas E. coli* BST Library. 50 known source samples is the target number of sources to collect; 2 *E. coli* isolates will be analyzed by ERIC-RP per known source sample. Additionally, an *E. coli* density per gram of feces will be determined for each processed sample. | | | |
| | Start Date | Month 4 | Completion Date | Month 20 |
| Subtask 4.4: | USDA-ARS will collect 20 surface water runoff samples from each of 3 designated catchments (un-grazed rangeland, cropland, managed hay pasture) at the USDA-ARS Grassland Research Center in Riesel. 60 runoff samples will be remitted to SAML for *E. coli* BST analysis. Five *E. coli* isolate will be analyzed by ERIC-RP per sample. | | | |
| | Start Date | Month 4 | Completion Date | Month 20 |
| Subtask 4.5: | USDA-ARS will collect 25 soil samples from each of 3 designated catchments (un-grazed rangeland, cropland, managed hay pasture) at the USDA-ARS Grassland Research Center in Riesel. 75 soil samples will be remitted to SAML for *E. coli* enumeration and BST analysis. Four *E. coli* isolate will be analyzed by ERIC-RP per sample. | | | |
| | Start Date | Month 4 | Completion Date | Month 20 |
| Subtask 4.6: | Using soil and water samples received, SAML will process samples using EPA Method 1603. *E. coli* colonies will be isolated from each sample processed and subjected to BST analysis. | | | |
| | | Month 4 | | Month 20 |
| Subtask 4.7 | SAML will compare *E. coli* isolates extracted from soil and water samples collected at these sites to *E. coli* strains isolated and typed in Subtask 4.3 and other included in the Texas *E. coli* BST Library using the ERIC-RP methodology. | | | |
| | Start Date | Month 16 | Completion Date | Month 20 |
| Subtask 4.8 | SAML will develop descriptive write up of BST technical approach and its results for inclusion in the project final report. | | | |
| | Start Date | Month 18 | Completion Date | Month 21 |
| Deliverables | • Contributing sources of *E. coli* identified for LU/LC types<br>• Estimated fecal loading rates for identified species contributing *E. coli* at selected sites<br>• Sources of *E. coli* contribution verified with BST | | | |

| **Tasks, Objectives and Schedules** | | | | |
|---|---|---|---|---|
| Task 5 | Education and Outreach | | | |
| Costs | $33,989 | | | |
| Objective | To compile project results into effective education and outreach that provides needed information to targeted audiences | | | |
| Subtask 5.1 | Project personnel will deliver project findings as appropriate at regional, state and national meetings to convey project findings to interested audiences and expand the utilization of project results. | | | |
| | Start Date | Month 1 | Completion Date | Month 24 |
| Subtask 5.2 | TWRI will maintain a program website to house information, findings and progress as well as serve as an avenue to expand education and outreach to larger audiences. | | | |
| | Start Date | Month 1 | Completion Date | Month 24 |
| Deliverables | • Documentation of meetings presented at and presentations posted on project website<br>• Program website developed and maintained | | | |

**Project Goals (Expand from Summary Page)**

The goals of this project aim to address several of the needs identified in the Bacteria TMDL Task Force report and advance the availability of bacterial growth, persistence and source information to watershed and water quality managers. To achieve this over-arching goal, the focused goals below will be achieved.

- The influences of sediment and water chemistry on simulated instream *E. coli* growth, persistence will be evaluated using lab-based, simulated stream environments where individual water quality parameters can be changed to illustrate *E. coli* response
- The sources of 'background' *E. coli* on multiple LU/LC types that are minimally impacted by anthropogenic sources of bacteria will be evaluated and verified by comparing results of contributing sources survey estimates and BST
- The development of future TMDLs and WPPs will be supported by providing critical information needed for improving the accuracy of computer based models to predict bacteria deposition rates; die-off, growth and persistence of *E. coli* while incorporating appropriate 'background' *E. coli* levels across multiple LU/LC types.

**Measures of Success (Expand from Summary Page)**

Project success will be determined by the completing the project tasks as described above. Specific successes will include:

- Completion of simulated instream evaluations of water quality constituent impacts on *E. coli* growth, persistence, and die-off characteristics as a result of variations in water quality parameters over time
- Quantifying levels of 'background' *E. coli* from soil and runoff samples collected from varying water quality conditions and LU/LC types utilizing library dependent BST technologies to differentiate between known animal/human sources of *E. coli* and 'background' sources
- Project results published/in process in peer-reviewed literature and disseminated to appropriate parties for incorporating improved *E. coli* decay, growth and die-off rates into computer-based modeling utilized in TMDL and WPP development

| ***2012 Texas Nonpoint Source Management Program* Reference (Expand from Summary Page)** |
|---|
| Goals and/or Milestone(s) |
| Component 1: Explicit short and long-term goals, objectives and strategies that protect surface water<br><br>Long-term Goal Objectives:<br>1: Focus NPS abatement efforts, …, and available resources in watersheds identified as impacted by NPS pollution<br>2: Support the implementation of state, regional and local programs to prevent NPS pollution through assessment, …, and education<br>3: Support the implementation of state, regional and local programs to reduce NPS (through the strategies approved in the Bacteria TMDL Task Force Report)<br>7: Increase overall public awareness of NPS issues and prevention activities<br><br>Short-term Goals and Milestones:<br>Goal 1: Data Collection and Assessment: coordinate with appropriate…entities and target water quality assessment activities in high priority, NPS-impacted watersheds,… where additional information is need<br>Objective: B: Ensure that monitoring procedures meet quality assurance requirements and are in compliance with EPA-approved TSSWCB quality management plan<br>Objective: C: Conduct special studies to determine sources of NPS pollution and gain information to target TMDL activities and BMP implementation<br>Goal 2: Implement …other state … programs …to reduce NPS pollution by targeting implementation activities to the areas identified as impacted or potentially degraded with respect to use criteria by NPS pollution<br>Objective: D: Implement other state approved plans (the Bacteria TMDL Task Force Report) to restore and maintain water quality in water bodies identified as impacted by NPS pollution<br>Goal 3: Conduct education…activities to help increase awareness of NPS pollution and activities which contribute to the degradation of water bodies…by NPS pollution<br>Objective: A: Enhance existing outreach programs at the state, regional, and local levels to maximize the effectiveness of NPS education<br>Objective: D: Conduct outreach through the Clean Rivers Program, AgriLife Extension, Soil and Water Conservation Districts and others to enable stakeholders and the public to participate in decision making and provide a more complete understanding of water quality issues…<br>Objective: G: Implement public outreach and education to maintain and restore water quality in waterbodies impacted by NPS pollution.<br><br>Milestones:<br>ST1/C: Watershed Characterization: The state will support the implementation of projects designed to evaluate watershed characteristics and produce the information needed for watershed and water quality models. |
| Component 2: Working partnerships and linkages to appropriate state, interstate, tribal, regional, and local entities,…and Federal agencies |
| Component 3: Balanced approach that emphasizes both state-wide NPS programs and on-the-ground management of individual watersheds |
| Component 4: Abatement of water quality impairments from NPS pollution and prevention of significant threats to water quality from present and future NPS activities. |
| Component 5: Identify waters and their watersheds impaired by NPS pollution and identifies important unimpaired waters that are threatened or otherwise at risk. Progressively address these identified waters by conducting more detailed watershed assessments and developing watershed implementation plans and then by implementing the plans. |

## Part III – Financial Information

| Budget Summary | | |
|---|---|---|
| **Category** | **Costs** | |
| Personnel | $ | 141,462 |
| Fringe Benefits | $ | 37,015 |
| Travel | $ | 3,086 |
| Equipment | $ | 0 |
| Supplies | $ | 72,640 |
| Contractual | $ | 20,000 |
| Construction | $ | 0 |
| Other | $ | 27,199 |
| | | |
| Total Direct Costs | $ | 301,402 |
| Indirect Costs (≤15%) | $ | 45,210 |
| | | |
| **Total Project Costs** | $ | 346,612 |

| **Budget Justification** | | |
|---|---|---|
| Category | Total Amount | Justification |
| Personnel | $ 141,462 | TWRI Project Specialist & QA Officer (4.8 mo/yr)<br>TWRI Communications Staff (1 mo/yr)<br>BAEN Hourly student worker (TBD: 15 hr/wk @ $10/hr for 40 wk/yr)<br>BAEN Associate Professor (1 mo annually)<br>IRNR/WFSC Graduate Student, MS level (TBD: 2.5 mo/yr)<br>SAML: Postdoctoral Research Associate (TBD: 6 mo/yr) |
| Fringe Benefits | $ 37,015 | Full Time: Salary*17.2% + $474/mo for insurance<br>Graduate Student: Salary*9.9% + $188/mo for insurance<br>Student Worker: Salary*9.9% |
| Travel | $ 3,086 | Sample Collection Events: 4 trips @ 2 days ea.<br>- 8 days per diem @ $46/day: $368<br>- 4 nights hotel @ $85/night: $340<br>Conferences: 2 trips @ 4 days ea.<br>- Airfare to conference: 2 round trips est. @ $600 ea: $1,200<br>- 8 days per diem @ $46/day: $368<br>- 6 nights conference hotel @ $135/night: $810 |
| Equipment | $ 0 | N/A |
| Supplies | $ 72,640 | 3 flow chambers @ $50 ea.<br>3 circulation pumps @ $125 ea.<br>9 storage/transport containers for substrate collection @ $25 ea.<br>4 Coolers for water transport @ $35 ea.<br>miscellaneous flow chamber supplies (pipe, glue, fittings, etc.) @ $100<br>2 YSI 6883 Ammonium Probes @ $500 ea.<br>2 YSI 6884 Nitrate Probes @ $500 ea.<br>2 YSI 6136 Turbidity Probes @ $1,600 ea.<br>Disposable supplies for lab analysis (160 E. coli enumerations @ $30 ea.)<br>Sampling consumables (gloves, whirlpaks, reagents, standards, media, etc.) @ $4,000<br>Camera trapping supplies (batteries, posts, etc.) @ $1,000<br>SAML: EPA method 1603 supplies: 185 samples @ $30 ea.<br>SAML: ERIC-PCR supplies : $8/isolate; 100 fecal source; 300 water isolates; 300 soil isolates<br>SAML: RiboPrinting supplies: $65/isolate; 100 fecal source; 300 water isolates; 300 soil isolates |
| Contractual* | $ 20,000 | USDA-ARS: See additional justification below for details |
| Construction | $ 0 | N/A |
| Other | $ 27,199 | Peer-reviewed Publication Costs @ $4,500<br>Dissolved Organic Carbon Analysis (SCSC NAWA Lab) 100 @ $10 ea.<br>Orthophosphorus Analysis (SCSC NAWA Lab) 100 @ $10 ea.<br>IRNR/WFSC Graduate Student tuition and fees @ 8,758<br>Conference registration fees @ $1,200<br>State Vehicle Mileage: 9,009 miles @ $0.555/mi: $5,000<br>- TWRI/BAEN: 6,009 miles<br>- IRNR: 3,000 miles<br>General Maintenance: (bacteria hood, freezers, inspections, etc.) @ $2,000<br>BAEN Administrative Fee (11% of BAEN MTDC) @ $3,741 |
| Indirect | $ 45,210 | 15% of Total Direct Costs |

| **Contractual Budget Justification – USDA-ARS** | | |
|---|---|---|
| Category | Total Amount | Justification |
| Personnel | $ 0 | N/A |
| Fringe Benefits | $ 0 | N/A |
| Travel | $ 0 | N/A |
| Equipment | $ 0 | N/A |
| Supplies | $ 0 | N/A |
| Contractual* | $ 0 | N/A |
| Construction | $ 0 | N/A |
| Other | $ 20,000 | Miscellaneous water and soil sampling expendables, other incidental expendables in assisting with LU/LC based wildlife density estimates |
| Indirect | $ 0 | N/A |